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ABSTRACT

This study investigated the relationship between the stressfulness of each state's social environment, smoking, and mortality rates for respiratory cancer. It was based on a health behavior model which assumed that under conditions of high stress some people fail to exercise normal prudence in either protecting their health or engage in practices inimical to health. Two types of social stress were conceptualized and measured at the state level: one based on life changes requiring adaptation and measured by an index in which negative personal life events in 15 categories were aggregated for each state using macro measures, the second based on the idea of chronic stressful conditions and measured through the Measure of Status Integration. Smoking was measured by tobacco sales and by a survey of percent smoking by state. Both stressful events and stressful conditions were correlated with all indicators of smoking at the state level, 12 of 14 correlations being in the theoretically expected direction. Correlations were enhanced when age, urbanicity, the percentage of blacks, education, and low income were controlled. The data were compatible with a causal model suggesting that socially generated stress in states increases the level of smoking behavior which in turn soon leads to higher death rates for cancer of the respiratory system. Although stress and smoking have been previously linked at the individual level and the smoking/cancer link has long been established, this study appears to be the first to link living in stressful geographic locales with the increased health risk of respiratory cancer. (Author/AA)

SOCIAL STRESS, SMOKING BEHAVIOR AND MORTALITY FROM CANCER OF THE RESPIRATORY SYSTEM: A MACRO-SOCIAL ANALYSIS

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Abstract

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This paper reports on an investigation of the relationship between the stressfulness of each state's social environment, smoking, and mortality rates for malignant neoplasms of the respiratory system.

In contrast to prevailing models of the health-disease process such as the "direct physiological arousal" model (Holmes, Selye), the "cognitive model" (Lazarus) and the "patient role" model (Mechanic), the present research is based on "a health behavior model" which assumes that under conditions of high stress some people fail to exercise normal prudence in either protecting their health or engage in practices inimical to health.

Two types of social stress are conceptualized and measured at the state level: the first, the "life events" model, is based on life changes that require adaptation. An index is described in which (negative) personal life events in 15 categories (e.g. divorces and plant closings) are aggregated for each state using macro measures. The second model is based on the idea of chronic stressful conditions, and is measured through the Measure of Status Integration. Smoking is measured by tobacco sales and by a survey of percent smoking by state.

Both stressful events and stressful conditions are correlated with all indicators of smoking at the state level, 12 of 14 correlations being in the theoretically expected direction. Correlations are enhanced when age, urbanicity, the percentage Blacks, education and low income are controlled for.

Our data are compatible with a "causal model" that socially generated stress in states increases the level of smoking behavior which in turn soon leads to higher death rates for cancer of the respiratory system. Although stress and smoking have been previously linked at the individual level through surveys and experiments and the smoking/cancer link has been established for many years, this is the first study, to our knowledge, that links living in stressful geographic locales with the increased health risk of respiratory cancer.

SOCIAL STRESS, SMOKING BEHAVIOR AND MORTALITY FROM CANCER OF THE RESPIRATORY SYSTEM: A MACRO-SOCIAL ANALYSIS

This paper reports on an investigation of the relationship between the stressfulness of each state's social environment, smoking, and mortality rates for malignant neoplasms of the respiratory system. It employs a macro-social approach within which the 50 states serve as the units of analysis.

Several decades of research have helped establish a correlational link between stress and disease that encompasses an impressive number of physical and mental disorders (cf. Dohrenwend and Dohrenwend, 1981; Elliott and Eisendorfer, 1982; Bielauskas, 1982).

In explaining the link between stress and disease several models compete (Dohrenwend and Dohrenwend, 1981). In the "direct physiological arousal" model, stressors appear to operate directly on the physical organism of the individual resulting in disease-generating processes. These processes occur at a direct and pre-rational level (Holmes and Rahe, 1967; Selye, 1956) and therefore do not require the mediation of psychological processes. In the "cognitive" model of stress, on the other hand, various psychological processes such as cognitive appraisal, anxiety, psychological discomfort and perceived threats mediate the stress-disease relationship (Lazarus, 1966).

Still a third model of the stress-illness relationship focuses on the "patient role" in which individuals are more likely to pay attention to their own symptoms, to report these symptoms in interviews, to seek medical care, and to take more time off from work when sick in comparison to less stressed persons of equivalent health status (Mechanic, 1976).

The above models are most common but do not exhaust the theoretical possibilites. The current study involves a different and less common model in which "health-related behaviors" are viewed as the intervening process between stress and disease. That is, under conditions of stress some people fail to exercise normal prudence in either protecting their health or engaging in practices inimical to health.

An earlier study by the current authors found support for the "health behavior model" in the area of stress and alcohol problems. Stressful events and ongoing stressful conditions were both linked to greater consumption of alchoholic beverages which in turn were linked to a number of alcohol-related problems (Linsky, Straus and Colby, 1985; Linsky, Colby and Straus, 1985). We also found that fatal accidents from a variety of causes were associated with life in stressful environments and those correlations could not be explained away by other factors. (Linsky and Straus, 1986)

METHODS

Measurement of Social System Stress

Our investigation is based on data for the United States with states serving as the units of analysis[1]. A recent monograph by Linsky and Straus (1986) described the development of a State Stress Index based on the "life events" concept of stress measurement (Holmes and Rahe, 1967). The life events approach asserts that the accumulation of stressful events such as divorce, job loss, change of residence or working conditions, is likely to be a precursor to the onset of changes in physical and mental health.

Our investigations took the life events approach and moved the focus to the level of the social system. This was accomplished by aggregating the total number of stressful life events occurring within different geographical units (i.e., states and regions of the United States). Fifteen indicators reflecting the rate of stressful events in each state were combined into the composite State Stress Index. (Divorce, abortions, illegitimate birth, infant deaths, fetal deaths, business failures, new unemployment, work stoppages, bankruptcies, mortgage foreclosures, families assisted in disasters, new migrants, new housing units, new welfare recipients, and high-school dropouts.) Using the State Stress Index, we were able to rank and compare the stressfulness of

different states and regions throughtout the country. In our opinion, this provides the most comprehensive and rigorous attempt to date to measure the stressfulness of living in different areas of the country.

(Table 1 and Figure 1 about here)

State Differences in Stressor Events

Table 1 and Figure 1 show the U.S. distribution of stressor events. The states with the consistently highest SSI scores are located in the Pacific, and Mountain regions of the country. This could be described as a "frontier" pattern since it centers on states that are Western, most recently admitted to the Union and not heavily settled. The states lowest in stress are those located in the West North Central region of the country, followed by the New England area. While this geographic distribution of societal stress is interesting in its own right, our focus in the current research is on how such stress is relevant to excessive smoking and to the distribution of respiratory cancer.

Measurement of Smoking

The principle indicator of state smoking levels in this study is the average sale of cigarettes per capita. Sales data are probably the best indicator of tobacco consumption on a nationwide basis, but like any indicators, they have important limitations. For example, the figures do not include illegal sales of cigarettes. They are based on location of purchase

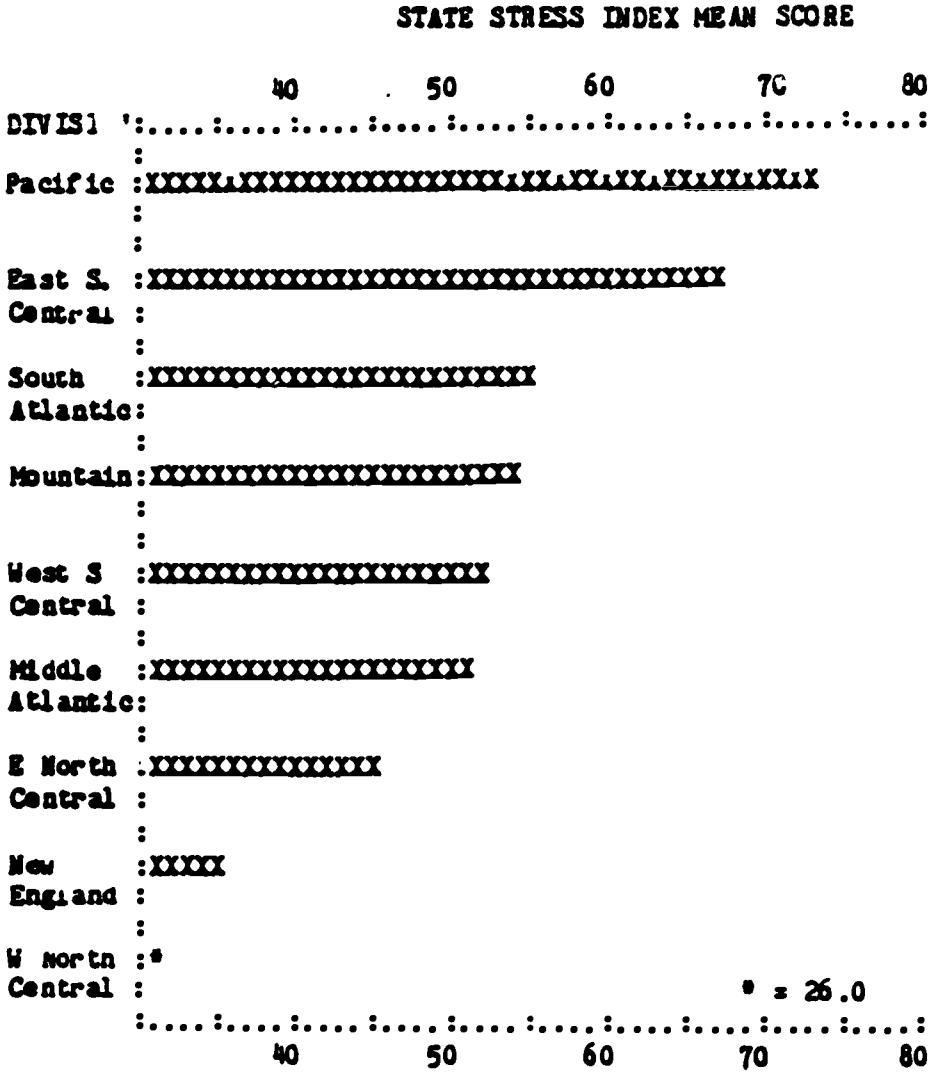


Figure Mean SSI Score by Census Divisions

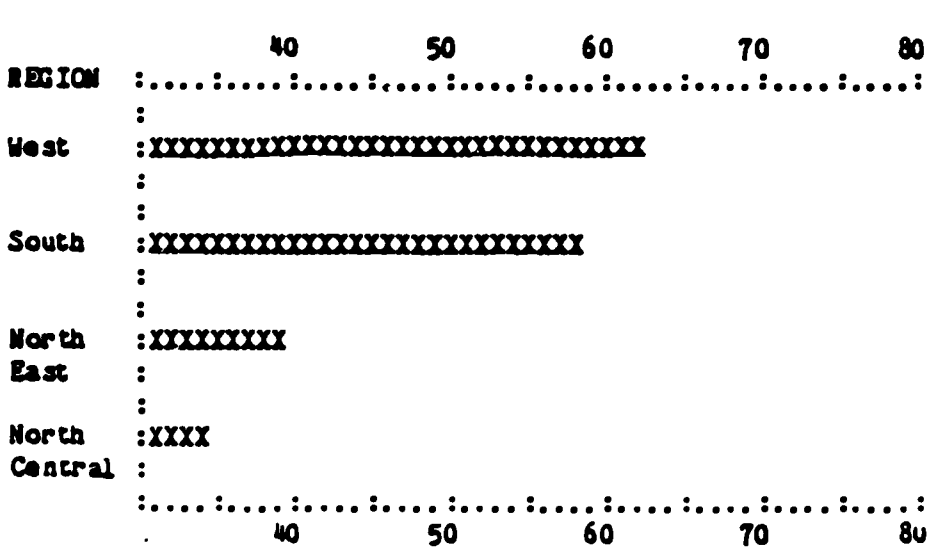


Figure 1 . Mean SSI Score by Census Region

TABLE 1

Rank of the States on the State Stress Index Measures of Smoking and Mortality from Respiratory Cancer

State Stress Index			Smoking Measures: Av Per Cap. Consumption Packs Per Person			Smoking Measures: Percent Smoking Cigarettes			Deaths from Cancer of the Respiratory System Per Million		
Case	VIA	TX152	Case	VIA	Z307	Case	VIA	Z308	Case	VIA	T01R
1	NEV	104.	1	N.H.	290.5	1	INDI	38.2	1	FLA	69.22
2	ALAS	87.	2	KY	230.9	2	N.C.	37.7	2	R.I.	55.93
3	GA	82.	3	N.C.	230.2	3	KY	36.6	3	W.VA	53.60
4	WASH	80.	4	NEV	201.4	4	ALAS	36.0	4	OKLA	53.34
5	OREG	78.	5	VT	171.1	5	COLO	34.4	5	KY	52.73
6	ALA	77.	6	IND!	166.6	6	PA	34.0	6	NEV	50.82
7	CAL	76.	7	ALAS	164.8	7	VA	33.6	7	DEL	50.69
8	MISS	74.	8	WYO	161.5	8	TENN	32.4	8	ARK	49.69
9	ARIZ	72.	9	VA	158.1	9	FLA	32.3	9	ME	48.86
10	TENN	71.	10	OREG	156.5	10	W.VA	32.2	10	N.H.	48.84
11	COLO	65.	11	DEL	153.0	11	ARIZ	32.0	11	TENN	48.55
12	OKLA	62.	12	R.I.	150.2	12	N.J.	31.8	12	N.J.	48.46
13	S C.	61.	13	ME	144.9	13	WYO	31.5	13	MD	48.11
14	FLA	61.	14	LA	139.6	14	MICH	31.1	14	VT	47.76
15	MICH	59.	15	MD	139.5	15	DEL	30.6	15	PA	47.48
16	N.Y.	59.	16	OKLA	138.6	16	ALA	30.5	16	N.Y.	47.37
17	ILL	59.	17	MICH	138.0	17	OHIO	30.2	17	LA	47.34
18	IDA	57.	18	MD	137.1	18	TEX	29.9	18	WASH	47.07
19	VA	54.	19	S C.	136.8	19	IOWA	29.6	19	OREG	46.89
20	KY	52.	20	ILL	134.4	20	N.M.	29.1	20	OHIO	46.92
21	OHIO	51.	21	COLO	134.2	21	N.H.	29.1	21	ALA	46.81
22	LA	51.	22	FLA	130.3	22	GA	28.6	22	MISS	45.77
23	DEL	50.	23	W.VA	129.7	23	CAL	28.4	23	MD	45.69
24	MD	50.	24	CAL	128.0	24	ARK	26.8	24	ILL	45.26
25	N J.	49.	25	KANS	127.7	25	MONT	25.7	25	CONN	44.89
26	N.C.	48.	26	GA	125.9	26	NEBR	23.2	26	MASS	44.72
27	TEX	47.	27	N.D.	125.4	27	KANS	22.1	27	INDI	44.44
28	N.M.	47.	28	IDA	125.1				28	CAL	44.30
29	ARK	47.	29	MONT	124.9				29	KANS	43.13
30	PA	46.	30	OHIO	124.6				30	VA	42.31
31	W.VA	44.	31	N.Y.	124.6				31	MICH	42.07
32	MD	43.	32	IOWA	124.4				32	TEX	41.19
33	KANS	42.	33	N.J.	122.4				33	NEBR	41.07
34	IIAWA	42.	34	ARIZ	122.3				34	GA	40.71
35	INDI	40.	35	TENN	121.7				35	IOWA	40.34
36	R.I.	37.	36	TEX	121.4				36	ARIZ	40.02
37	CONN	35.	37	MISS	120.9				37	N.C.	39.11
38	ME	35.	38	ARK	119.1				38	S.C.	38.56
39	WYO	35.	39	PA	118.8				39	S.D.	37.65
40	VT	34.	40	NEBR	118.1				40	MONT	37.35
41	MASS	34.	41	MASS	116.9				41	WYO	37.23
42	MONT	33.	42	S.D.	116.7				42	WISC	36.48
43	MINN	28.	43	MINN	116.7				43	MINN	34.07
44	UTAH	26.	44	ALA	116.2				44	IOA	31.52
45	N.H.	26.	45	WISC	115.4				45	IIAWA	28.27
46	WISC	20.	46	CONN	113.4				46	COLO	26.96
47	N.D.	19.	47	N.M.	102.4				47	N D.	26.41
[illegible]	S.D.	17.	48	WASH	100.3				48	N.M.	26.06
[illegible]	IOWA	17.	49	IIAWA	99.4				49	ALAS	19.13
[illegible]	NEBR	16.	50	UTAH	77.8				50	UTAH	14.81

rather than residence of the customer. Thus sales figures may be inflated for states with lower cigarette taxes than their neighbors because of cross-over purchases by "out-of-staters." We return to this problem in the analysis section.

Tobacco sales, despite these limitation, remain the only indicator of consumption available for the entire set of states and are used as the main source of date in this study. However, because of the limitations of the sales figures, we employ a second source of data from a telephone survey of health-related behaviors conducted by the Centers for Health Promotion and Education (1984). Members of their sample were asked if they currently smoked. The major limitation of the Center's study is that it is available for only 28 of the 50 states and respondents were not asked how much they smoked, but only whether they smoked or not. However, their total sample is large enough (N=70,000) to permit estimates for separate state rates of smoking and it does avoid the "sales bias."

STRESS AND SMOKING

The possibility that heavy smoking may be a nervous habit in response to stressful situations or conditions is intuitively plausible but there are comparatively few empirical studies linking these two variables. Smoking was found to be heavier within stressful situations by Schachter et al. (1977a; 1977b)

in a series of laboratory experiments. Lindenthal et al. (1972), in a survey, also reports heavier smoking among persons experiencing more stressful life events in comparison to other persons. Lindenthal et al. survey was limited by a cross-sectional design. Conway et al., on the other hand, conducted a longitudinal study in which a group of seamen assigned to a naval training center were followed over an eight month period (Conway et al., 1981). Smokers were monitored during both high and low stress periods. In general, there was more cigarette smoking on days in which stress (both objective and subjective) was high.

The findings from this handful of studies are consistent with the hypothesis that stressful events or conditions lead to higher levels of smoking behavior. However, each of the above studies deals with stressors and smoking at the individual level and involves relatively small samples. The current study, on the other hand, deals with stressor levels within social systems and the rates of smoking for state populations. In addition, we examine death rates attributed to pulmonary and throat cancer, thus allowing a partial examination of processes linking community-based stressors, high rates of smoking, and higher levels of cancer of the respiratory system.

State Differences in Smoking Behavior

Examination of the state-to-state differences in smoking behavior fail to reveal clear regional patterns. Indiana, North

Carolina, Kentucky and Alaska were the highest of the 28 states reported for percent smoking. Kansas, Nebraska and Montana were lowest. New Hampshire , Kentucky, North Carolina and Nevada were highest on cigarette packs sold per capita, while Washington, Hawaii and Utah were lowest for the 50 states reported.

The correlation between the two measures of smoking (sales of packs per capita and percent smoking) was .39, indicating some correspondence between the two, but they are far from isomorphic. Because the two indicators appear to be measuring differnt aspects of smoking behavior, it was decided to include both measures in the study.

Examination of state cigarette sales in Table 1, column 2, shows three outliers (over 2 1/2 times the standard deviation from the mean). These three states were North Carolina, Kentucky and New Hampshire. North Carolina and Kentucky are both leading tobacco-producing states which had by far the lowest cigarette taxes in the country and thereby the cheapest cigarette prices. In the third state, new Hampshire, taxes were not extreme by national standards but were substantially lower than her large neighboring states, Massachusetts and Maine. Thus in all three highest states there is the possibility that sales figures were substantially augmented by purchasers from out-of-state. For this reason, we decided to make two separate runs of all correlations involving cigarette sales: one with all 50 states, and one with 47 states with the three outliers removed.

FINDINGS

(Table 2 about here)

Table 2 reports on the correlations of the State Stress Index with malignant neoplasms of the respiratory system and the three indicators of smoking. State Stress is correlated with smoking in the direction hypothesized regardless of the indicator.

State stress is correlated with respiratory cancer for the total population and within three of the four subpopulations examined. Two of the correlations, total white population and female population, are significant (.24* and .49*** respectively).

The correlations involving stress and packs per capita (47 states) and the current consumption survey were significant at the .05 level, but the correlation between cigarette sales involving the entire set of states and state stress was an insignificant .18.

Sex Differences

Interesting sex differences in the stress-cancer relationship appear in Table 2. The stress-lung cancer connection in much stronger (.49) among females than among males (.12) even though the rate of smoking and the death rate for lung cancer are both higher among males.

TABLE 2

Correlations of SSI, Respiratory System Cancer Mortality

and Cigarette Smoking Per Capita

Dependent Variable	Correlation with State Stress Index	
	Zero-Order	5th Order Partial[1]
Respiratory Cancer '76		
Total	.18	.47***
White	.24*	.54***
Non-White	-.05	-.08
Male	.12	.42**
Female	.49***	.42**
Packs Per Capita '76 (N=50)	.07	.21
Packs Per Capita (N=47)	.32*	.48***
Current Cons. Survey (N=27)	.32*	.04

* Significant at the .05 level.
** Significant at the .01 level.
*** Significant at the .001 level.

1. Partials reported for White and Non-White are 4th order since we did not control for percent Black in this case.

In a parallel study by the current investigators on the relation between stressful events, stressful conditions and alcohol problems, similar sex differences were found in response to stress. The correlations of the SSI and the cirrhosis death rate (one of the measures of alcohol problems used in that study) were higher among women (.41) than among men (.33).

One explanation for this unanticipated pattern of findings lies in the nature of the stressful events included in the SSI. Several events relate importantly to women's family roles (divorces, infant deaths, fetal deaths, abortions and illegitimate births). Other events such as recent migration and moving to new housing, which tend to be disruptive of personal ties, could also have a greater impact on women than on men. Residential moves are more frequently made because of husbands' job changes but wives may bear the brunt of adjusting to the new community. Even economic and job-related stressors such as work stoppages and unemployment, which might affect men more than women owing to the centrality of work roles for men, may be extremely stressful for women because of the strains that these stressors place on entire families and because of women's special responsibility for the well-being of the family.

Markle and Troyer (1979) report that men smokers continue to outnumber women smokers, but the differences between the two have been narrowing. They report that women who work outside the home are more likely to smoke than other women, which leads those

authors to speculate that smoking may be symbolically linked with liberation for women. These same facts, in our view, could as well be interpreted as response to the increased stress of women entering competitive job markets in increasing numbers.

Partial Correlations

The overall pattern of correlations appears consistent with the stress and smoking hypothesis. One possibility worth considering is that the correlations are partly or wholly spurious, accounted for by factors such as age structure or other variables that are plausibly related to both smoking and stressor events. Through partial correlation, we controlled for the percentages of the population aged 55+, the percentage with 4 or more years of high school, the percentage of families below the poverty line, the percentage of Blacks and the percentage living in metropolitan areas. The right-hand column of Table 2 reports correlations between State Stress and the smoking-related variables, with these five additional variables controlled for simultaneously. If the correlations between stressful events and smoking behavior were either wholly or partly spurious, we would expect those correlations either to drop out or become significantly smaller under these conditions. However, the correlations for respiratory cancer for females becomes only slightly smaller (.42** versus .49***) and the correlations between stress and respiratory cancer for the total population,

for the white population, and for males all increase substantially. In addition, the two correlations between stress levels and cigarette sales increase substantially with the other variables controlled. Thus, if anything, the five control variables were suppressing the strength of the relationship between stressor events and the dependent variables.

Chronic Stress

Two conceptually separate approaches to social stress appear in the literature. The more dominant has been the stressful life events approach, described earlier. This approach emphasizes new demands or important changes in people's life situations that require adaptation. Our SSI is based on such a conceptualization of stress.

A second approach emphasizes stressful life conditions and situations (Pearlin et al., 1981). The emphasis is on the ongoing or chronic strains or conditions that exact a toll over time, not because of new adjustments required but because of the persistence of noxious or difficult factors in the individual's environment. Although most recent evidence linking social stress to illnesses and other maladaptive behavior has come from the life events approach, that approach is not necessarily the most efficacious for explaining all disorders (Pearlin et al., 1981). For these reasons we have included a measure of chronic social stress that has previously been employed in epidemiological

research on suicide and chronic disease, i.e. Gibbs and Martin's "Measure of Status Integration."

We view the distinction between stressful events and stressful conditions as conceptually important and have attempted to discriminate between them operationally. However, there is undoubtedly overlap between them. For example, a wife and mother may experience divorce as a highly stressful, if not traumatic, event but may also suffer the longer-term strains of diminished contact with her children, a lower standard of living, etc. business failures and work stoppages may have a long-term as well as immediate impact on communities.

Measures of Status Integration

Gibbs and Martin (1964) developed a complex measure for the degree of consistency between several statuses that individuals occupy at the same time e.g., marital, occupational, age groups, sex and race. Rarely occupied combinations of the above, e.g., young widows and unemployed husbands, have been found to be highly linked to suicide and mental pathology (Dodge and Martin, 1970; Gibbs and Martin, 1964). Such positions are presumably stressful because "poorly integrated" individuals are impeded from forming stable relations with others.

Low scores on the MSI indicate high status integration, a putatively low stressful conditions, while high scores indicate low integration and presumably highly stressful conditions.

TABLE 3

Correlation of the Measures of Status Integration,

Smoking and Respiratory Cancer in the United States

Dependent Variable		Correlation with MSI	
		Zero-Order Correlations	Fourth Order Partials[1]
Packs Per Capita	(N = 50)	-.06	-.13
Packs Per Capita	(N = 47)	-.10	-.35**
Current Consumer Survey of Smoking	(N = 27)	-.05	-.02
Malignant Neoplasms of Pulmonary System	(N = 50)	-.06	-.33**

1. The variable "% population age 55 and over" is omitted from the control variables to avoid confounding because the MSI includes age in its formula.

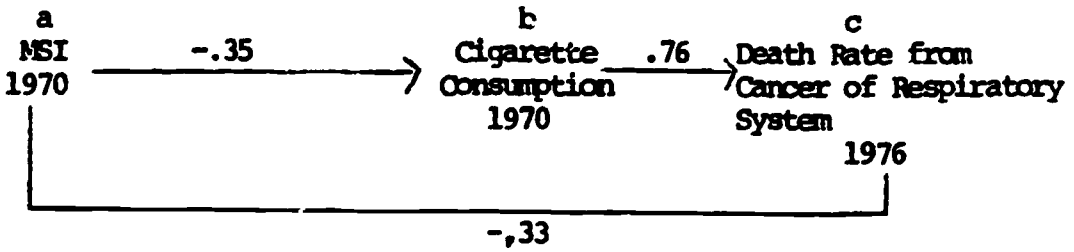
(Table 3 about here)

Chronic Stress and Lung Cancer

All of the correlations between MSI and the smoking-related outcomes are negative as expected by theory. The MSI correlations are lower than those reported in Table 2 for our measure of acute stress, the SSI, but two of the coreelations reach the .01 level of significance. As was the case with SSI, correlations are considerably higher once other important variables are controlled.

Time lag

From an epidemiological point of view it would be desirable to have a time lag of several years between stress and smoking behavior on the one hand and the incidence of deaths due to cancer of the respiratory system on the other. This is because a delay would normally be expected between the occurence of heavy smoking and the development of lung cancer and finally, mortality from that cancer. Analysis of such a delayed process or latency period was possible in this study with the MSI. The Measure of Status Integration used in this study is based on 1970 data since it is calculated from the decennial census. Consumption of cigarettes (average number of packs per person) was also available for the year 1970. A causal model consistent with the sequence suggested is diagrammed below.



The 1970 MSI was correlated -.33 (p .05) with the 1976 death rate for cancer of the respiratory system. If this model is correct, then the correlation should approach zero or be eliminated when earlier cigarette smoking is statistically controlled through partial correlation. Results of the partial correlation are consistent with this expectation (r ac.b = .12) and with the interpretation that social stressors lead to an increased consumption of cigarettes which soon eventuates in a higher death rate for cancer of the respiratory system.

CONCLUSIONS

This study represents the first time that social stress and smoking have been studies in relation to broadly based and systematic measures of the stressfulness of social environments. The correlations between stress and smoking are highly stable in that they occur no matter whether measures of stressful events (SSI) or stressful conditions (MSI) are employed and regardless of which measure of smoking behavior is used (average cigarettes

per capita or percent smoking). Correlations apply to males and females separately (although they are stronger for females) and do not appear spurious. In most cases the correlations are in fact enhanced when we control for extraneous variables.

Our data are compatible with a "causal model" that socially generated stress in states increases the level of smoking behavior which in turn soon leads to higher death rates for cancer of the respiratory system. At the same time there is no evidence from this data that suggests that social stress leads directly to lung cancer independent of the intervening factor of smoking behavior.

Although stress and smoking have been previously linked at the individual level through surveys and experiments and the smoking/cancer link has been established for many years, this is the first study, to our knowledge, that links living in stressful geographic locales with the increased health risk of respiratory cancer.

FOOTNOTES

1. The current investigation was prompted in part by recent availability of data on the 50 states and instrumentation that allows measurement and analysis of some of the dimensions discussed. The State and Regional Indicators Archive (SRIA) has recently been developed at the University of New Hampshire for the purpose of bringing together the vast array of data on the social and economic characteristics of the states that are available from diverse sources. The current holdings exceed 10,000 variables. See Straus (1985) for further information.

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